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Josephson effect in SIFS tunnel junctions with domain walls in the weak link region: In memory of V.F. Gantmakher

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Abstract

© 2015, Pleiades Publishing, Inc. We study theoretically the properties of SIFS type Josephson junctions composed of two superconducting (S) electrodes separated by an insulating layer (I) and a ferromagnetic (F) film consisting of periodic magnetic domains structure with antiparallel magnetization directions in neighboring domains. The two-dimensional problem in the weak link area is solved analytically in the framework of the linearized quasiclassical Usadel equations. Based on this solution, the spatial distributions of the critical current density, JC, in the domains and critical current, IC, of SIFS structures are calculated as a function of domain wall parameters, as well as the thickness, dF, and the width, W, of the domains. We demonstrate that IC(dF, W) dependencies exhibit damped oscillations with the ratio of the decay length, ξ1, and oscillation period, ξ2, being a function of the parameters of the domains, and this ratio may take any value from zero to unity. Thus, we propose a new phys-ical mechanism that may explain the essential difference between ξ1 and ξ2 observed experimentally in various types of SFS Josephson junctions.

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